NeuroMem for Neuro-MEMS
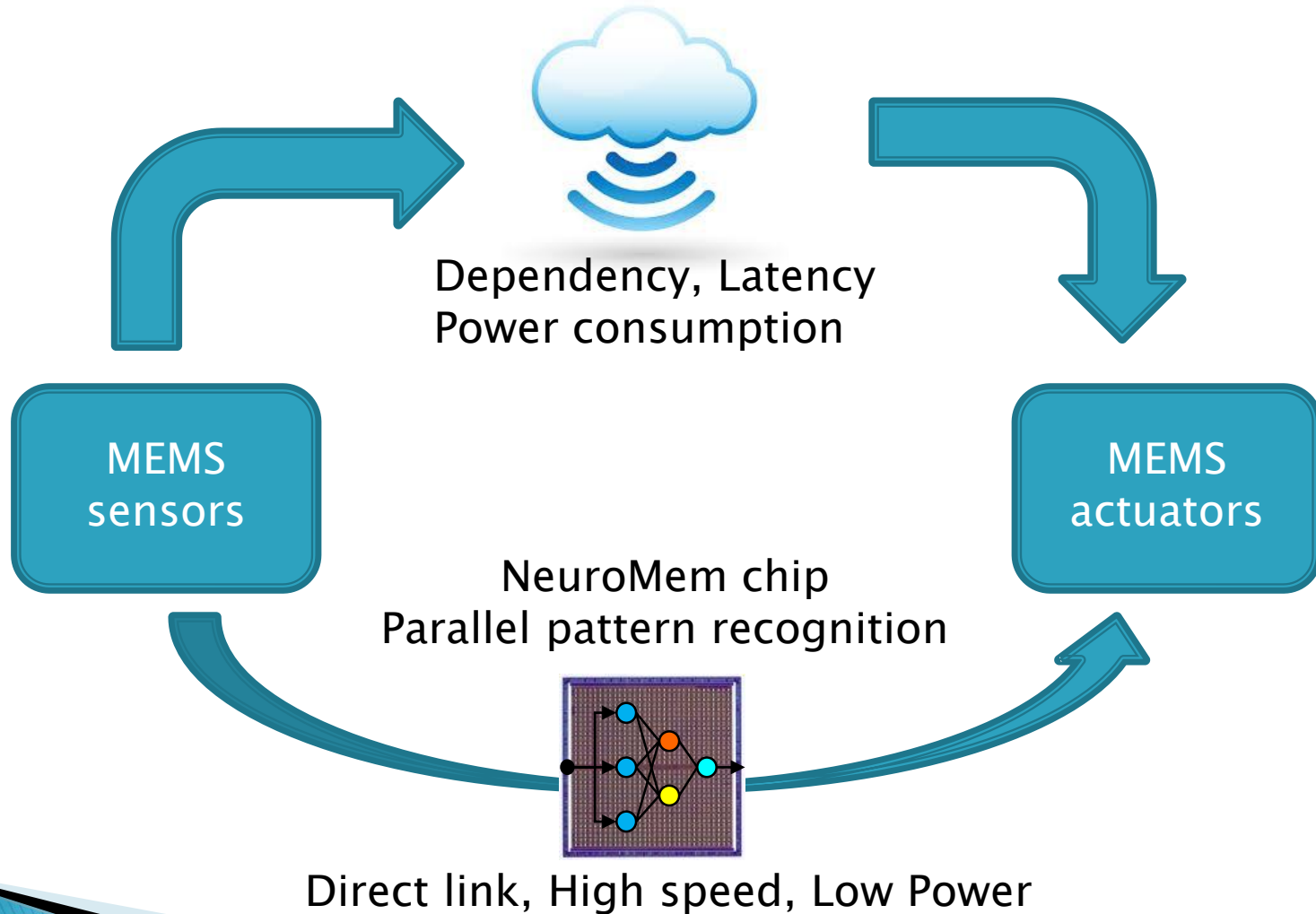
Bridging the gap between sensors and actuators with Neuromorphic Memories
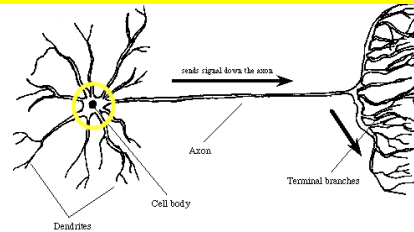
The missing brain

Dependency, Latency
Power consumption

MEMS
sensors

MEMS
actuators

NeuroMem chip
Parallel pattern recognition

Direct link, High speed, Low Power

Biologically inspired...
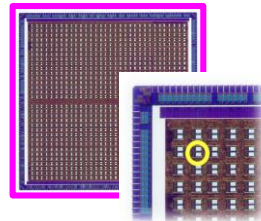
The brain is a repository of experiences associating **stimuli** to **actuators**

massive parallel wiring!

10 Billions neurons
100 Hz
25 Watts

NeuroMem is a parallel neural network associating **input patterns** to **categories**

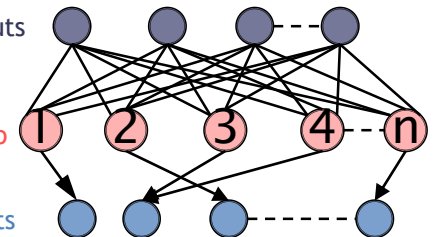Patented time domain multiplexing

1024 neurons
27 Mhz / 0.5 Watts

256 8-bit inputs

262,144 Synapses/chip (256 * 1024)

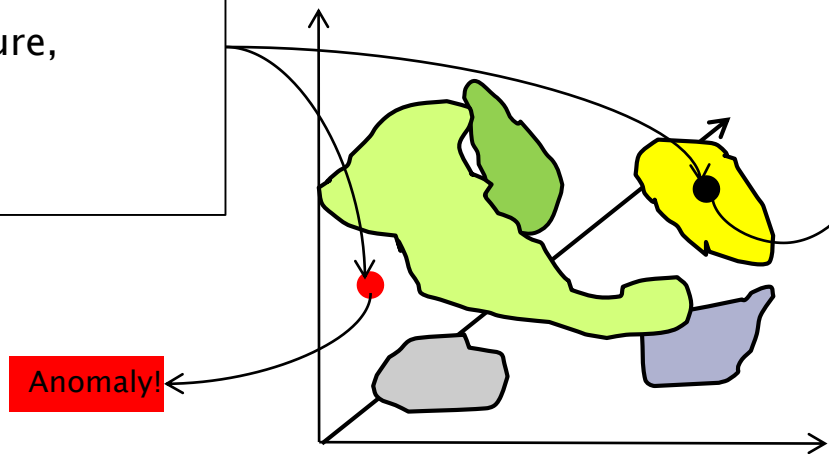32,766 outputs

1 2 3 4 n

Decision = Non linear classification

Input parameters =
- Voltage,
- Torque,
- Temperature,
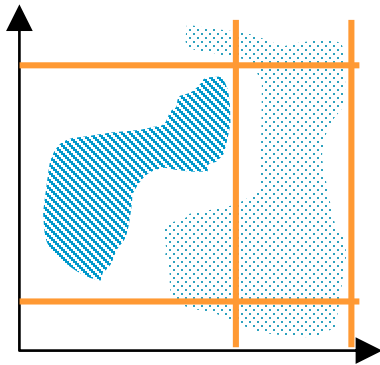- Vibration
- and more

Class =
Operation modes such as

Warm up

Light load

Medium load

Heavy load

Cool down

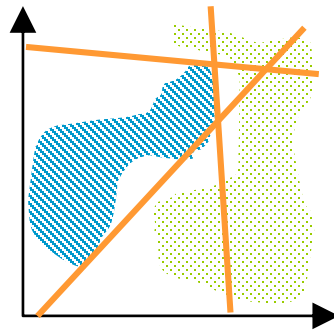Anomaly!

History of classifiers

1960: Threshold method
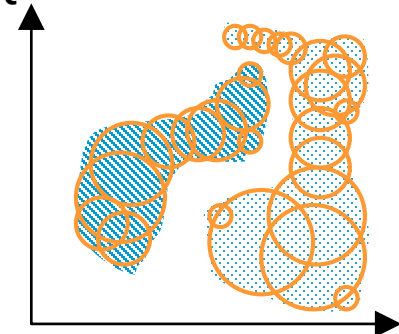Too simple and not non-linear

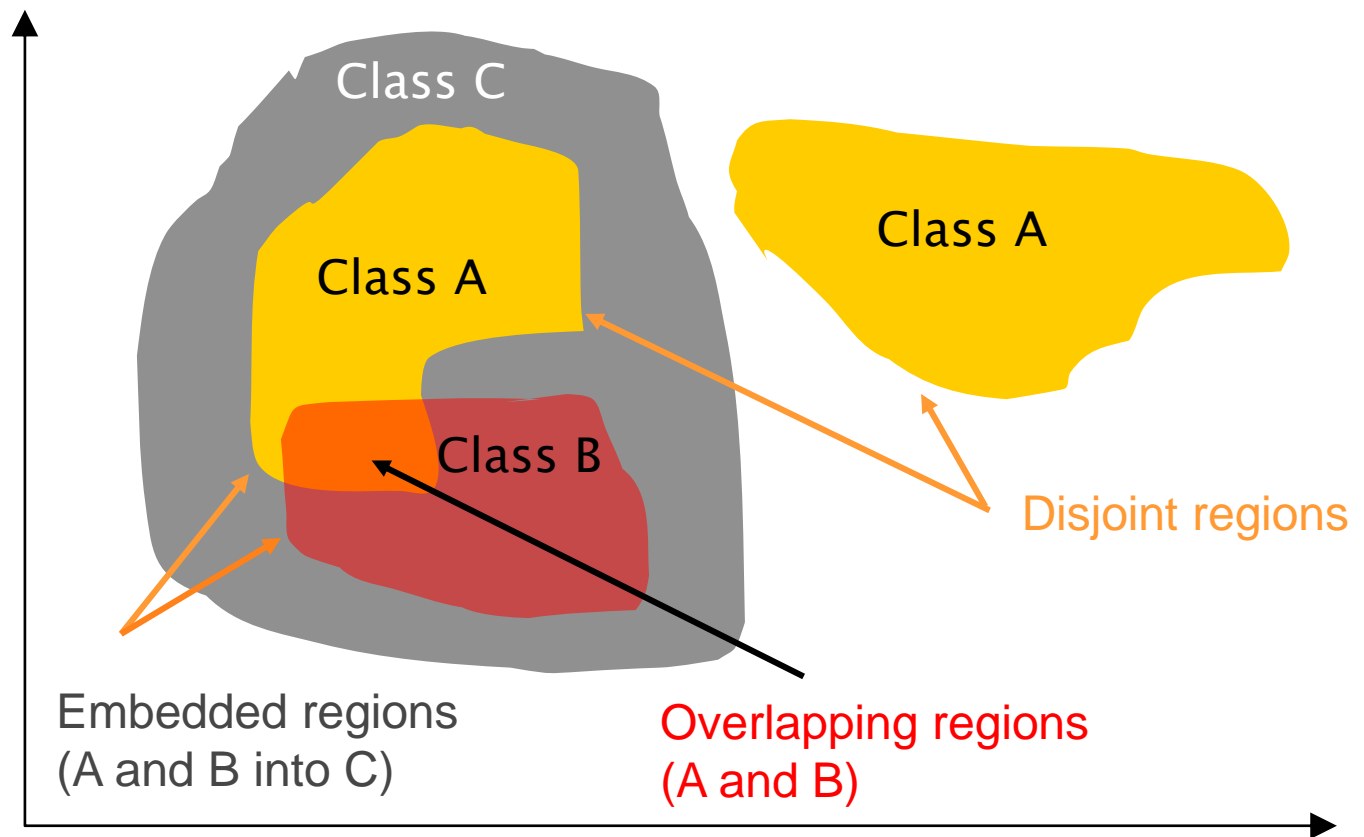1980: **Perceptron** method
Too complex,
and time consuming

1990: **Radial Basis Function**
Map spaces of any shape
with the relevant training
set

The power of a non-linear classifier

Radial Basis Function to associate and discriminate complex and large datasets
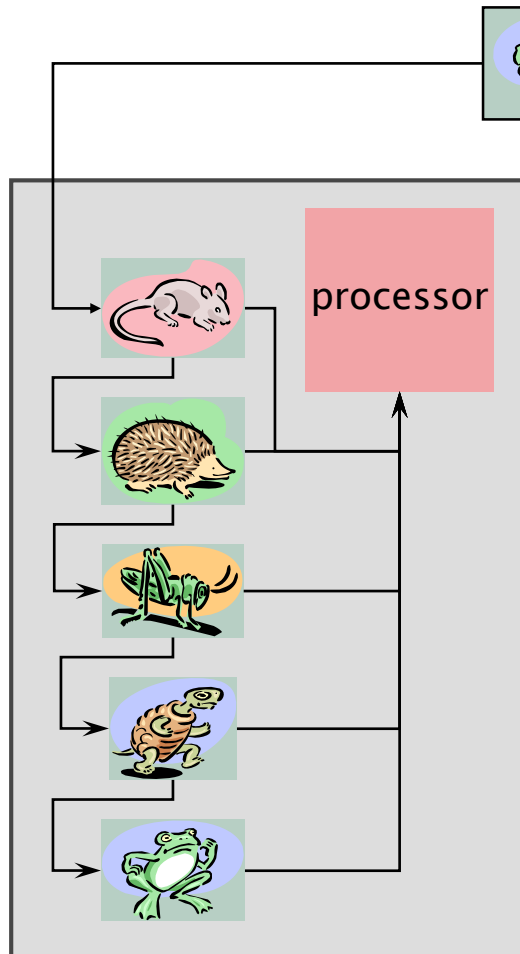

Class C

Class A

Class A

Class B

Disjoint regions

Embedded regions
(A and B into C)

Overlapping regions
(A and B)

The power of parallelism

Where is it?

CPU/DSP

NeuroMem

1 processor for <u>many</u> memory entries

Recognition in N cycles per entry UNTIL the right one is found

| processor |

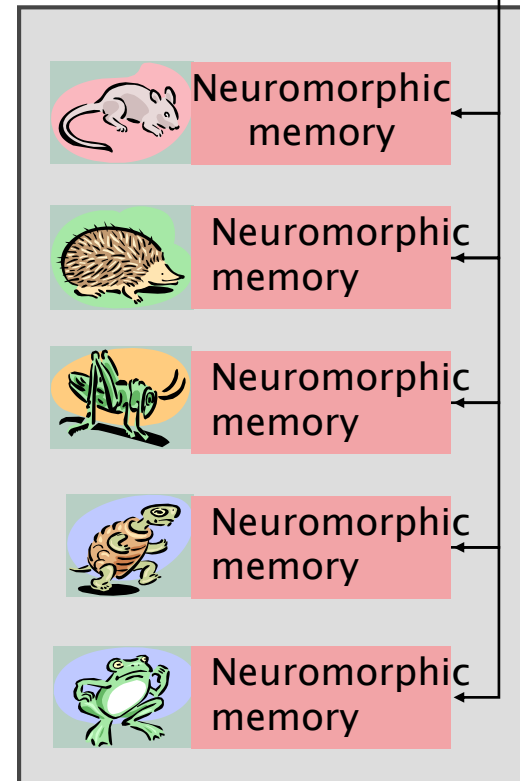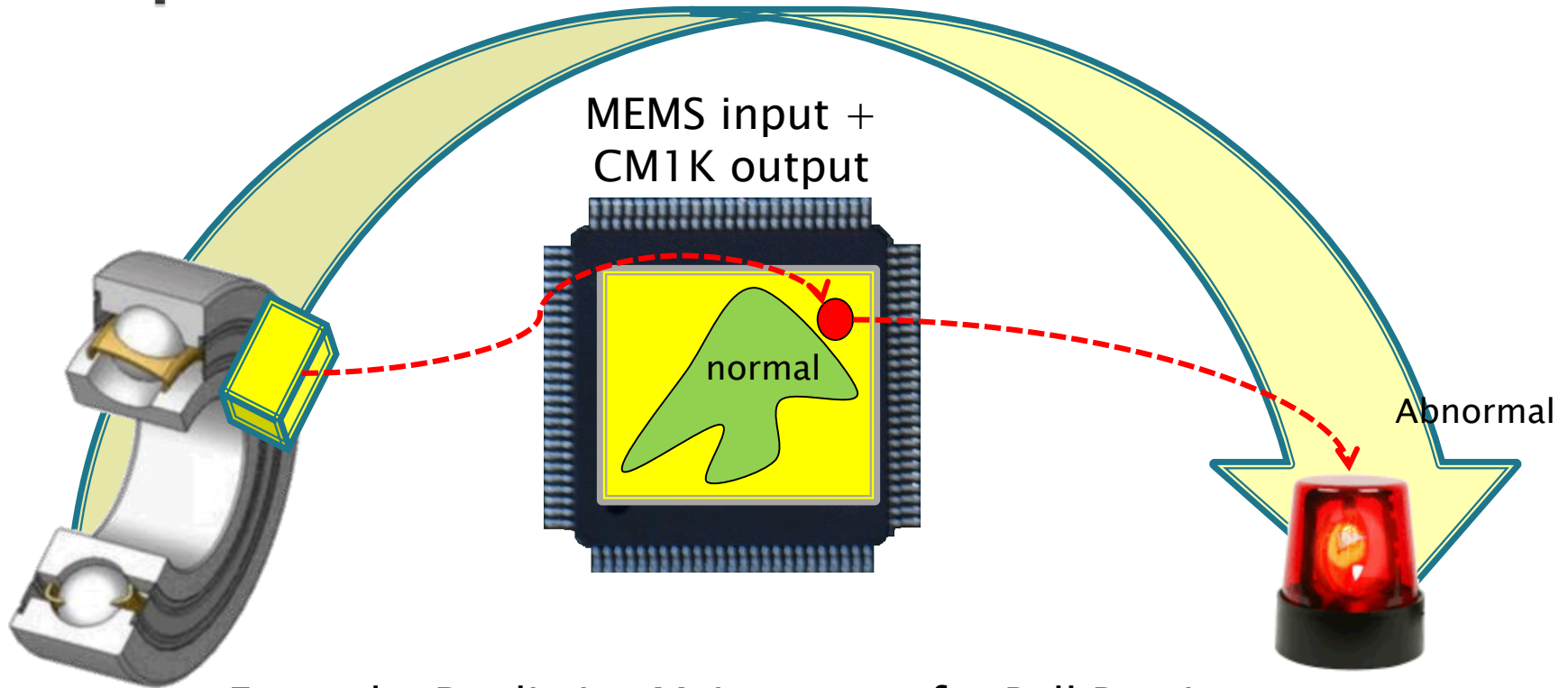| Neuromorphic memory |
| Neuromorphic memory |
| Neuromorphic memory |
| Neuromorphic memory |
| Neuromorphic memory |

Many memories with their own processing unit

Recognition in 16 cycles ∀ number of entries

The power of small foot print and low power

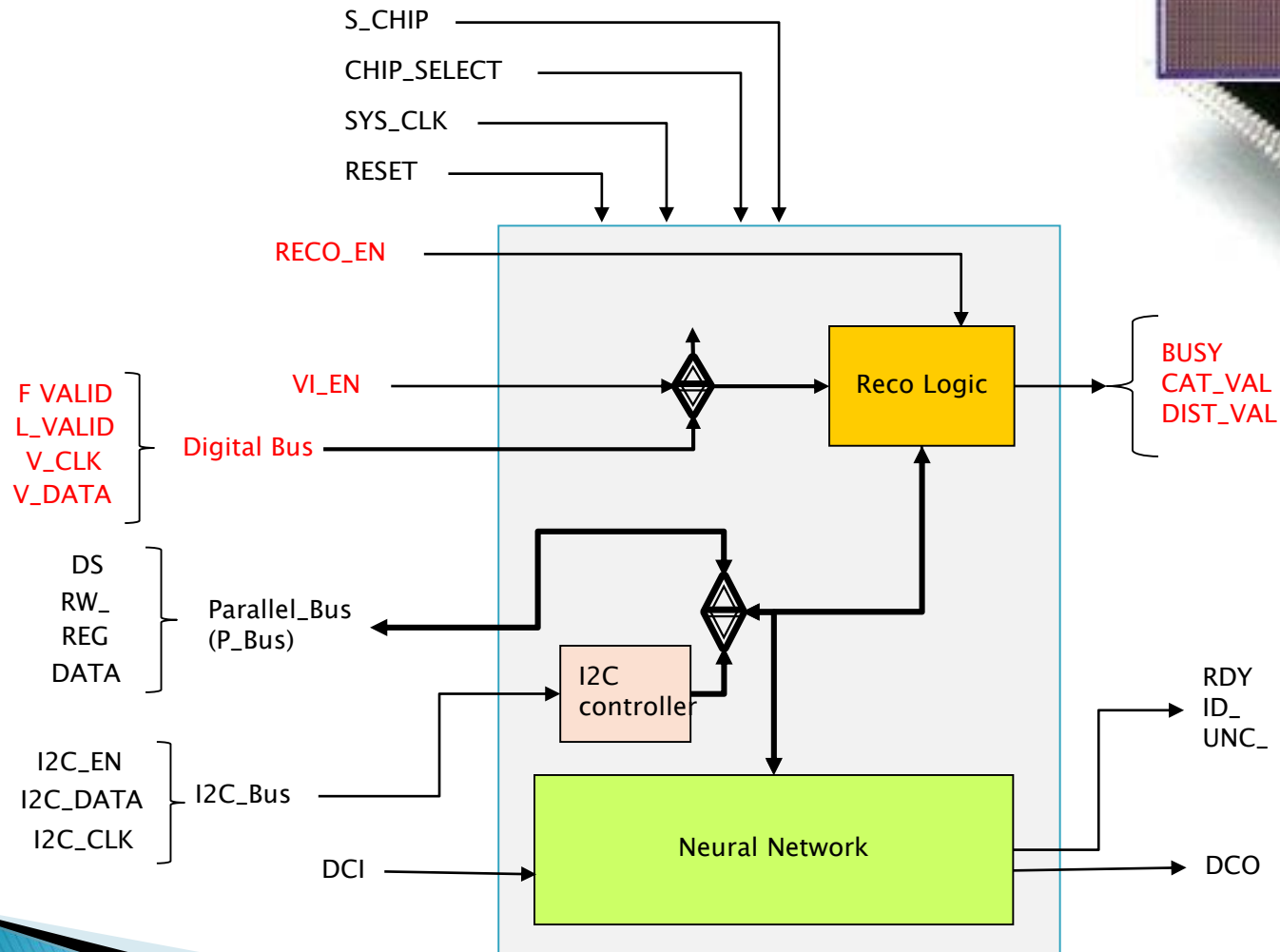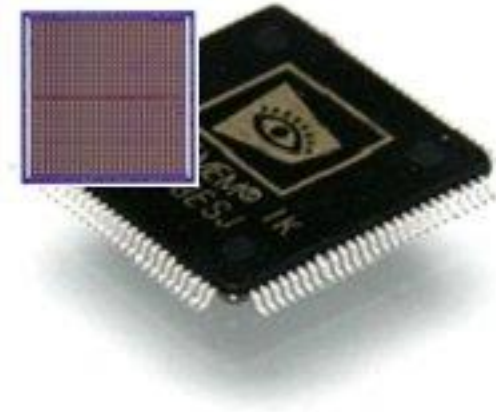MEMS input +
CM1K output

normal

Abnormal

Example: Predictive Maintenance for Ball Bearing
Semi-supervised learning
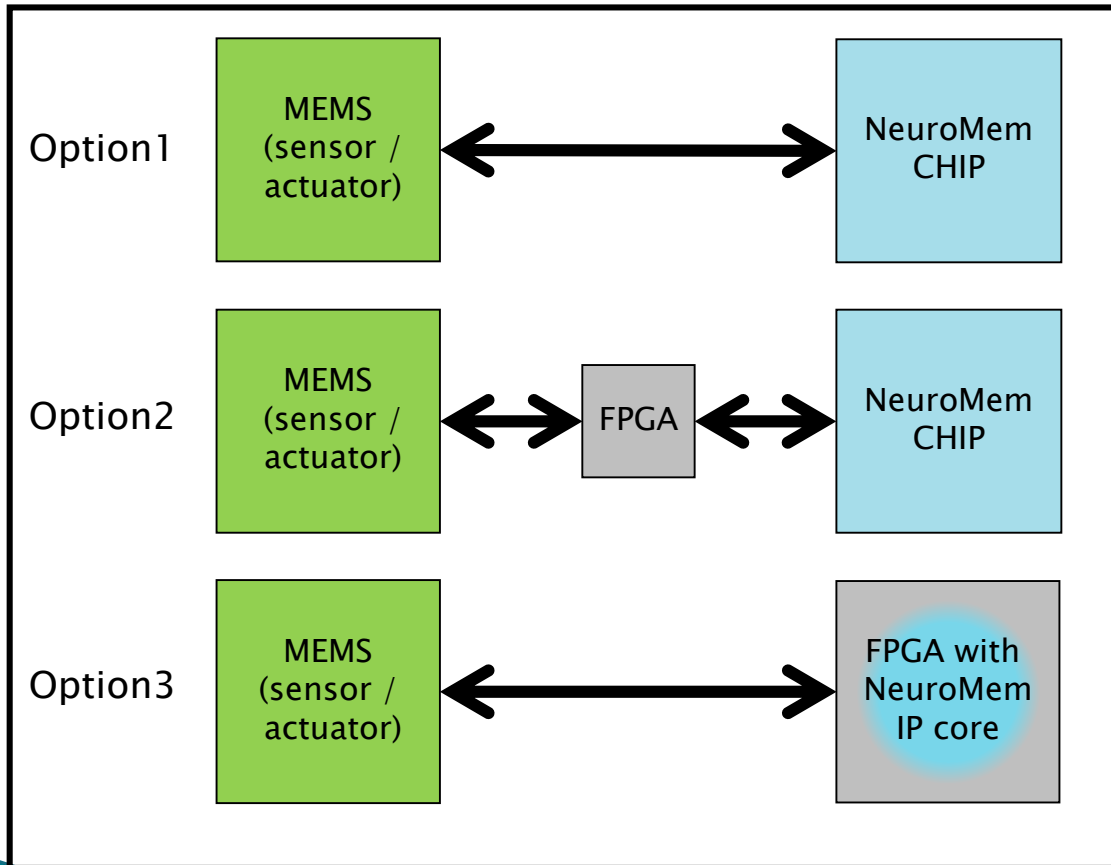Logging of abnormal vibrations
Novelties can be reviewed at later time and added to knowledge

CM1K I/O configuration

The Neuro-MEM concept

Today: multi-chips solution
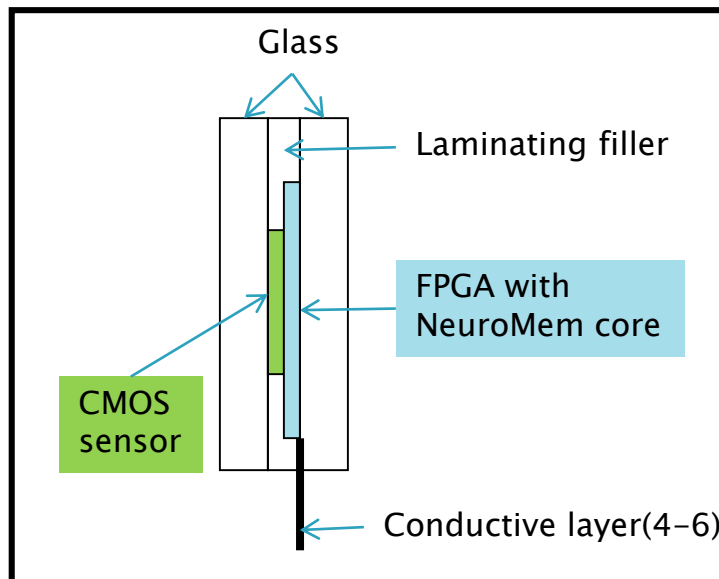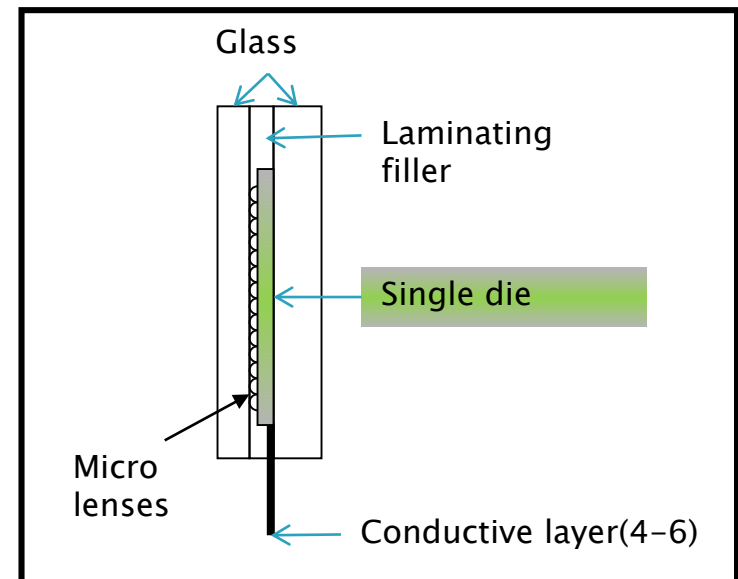
Tomorrow: SOC

Option1	MEMS (sensor / actuator) ⟷	NeuroMem CHIP
Option2	MEMS (sensor / actuator) ⟷ FPGA ⟷	NeuroMem CHIP
Option3	MEMS (sensor / actuator) ⟷	FPGA with NeuroMem IP core
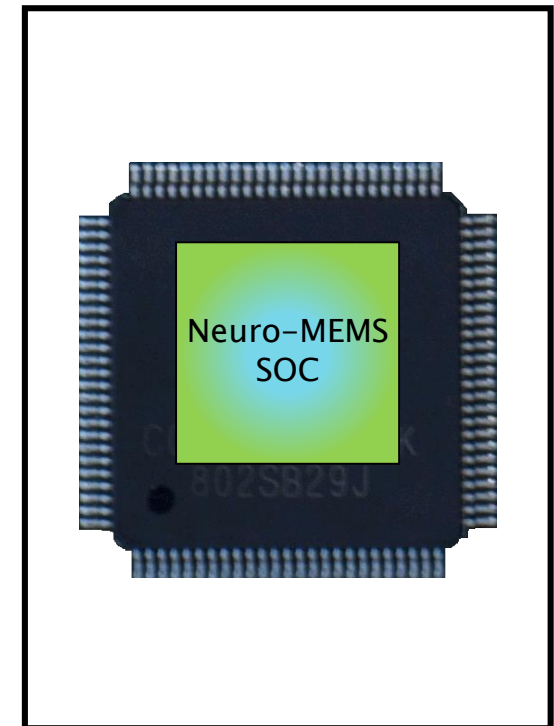
Neuro-MEMS SOC

Beyond Neuro-MEMS: Intelliglass

Sensor **+** NeuroMem **+** Glass **=** IntelliGlass

Patented by

AGC

GENERAL VISION

Today: multi-chips solution

Glass

Laminating filler

FPGA with NeuroMem core

CMOS sensor

Conductive layer(4-6)

Tomorrow: SOC

Glass

Laminating filler

Single die

Micro lenses

Conductive layer(4-6)

Biotech and Environmental Sciences

As a MicroArray reader

As a Lab-On-Chip

DNA Fragments (Gene) deposited on an IntelliGlass plate

CogniSensors
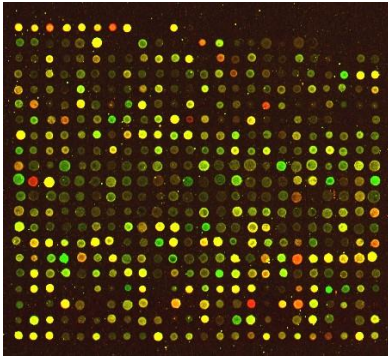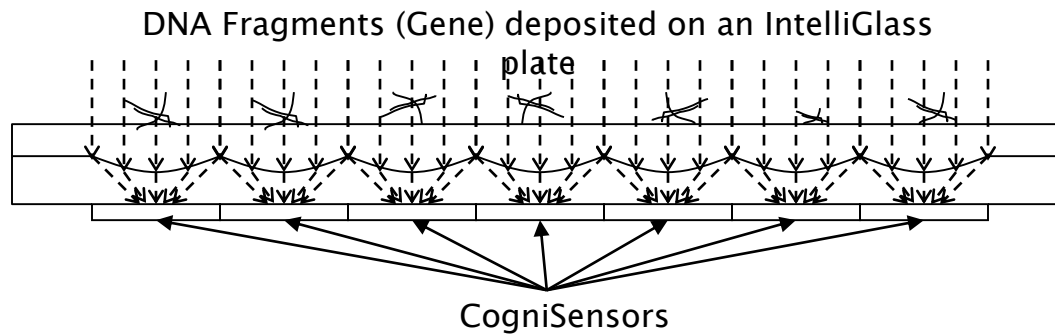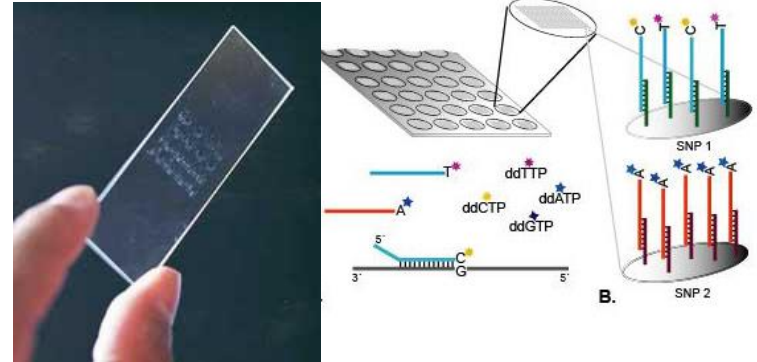
Consumer and mobile devices

- 3D Gesture human machine interface
- Activity monitoring
- Blood pressure monitoring
- Gaze tracking

Building and Infra-Structures

- Door control
- Glass breakage detection
- Crack detection
- Smoke detector

GENERAL VISION

- Developer of the NeuroMem Technology
  - Owner of the CM1K chip (1024 neurons)
- Developer of the CogniSight Technology
  - Image analytics based on NeuroMem hardware
  - Adaptive, trainable, high speed, low power
- Evaluation tools
- Technology Transfer
- IP Licensing (FPGA, ASIC)
- www.general-vision.com